US008534644B2

(12) **United States Patent**
Lundgreen et al.

(10) **Patent No.: US 8,534,644 B2**
(45) **Date of Patent: Sep. 17, 2013**

(54) **QUICK-ATTACH STEAM DISPERSION TUBES AND METHOD OF ATTACHMENT**

(75) Inventors: **James M. Lundgreen**, Lakeville, MN (US); **Jeffrey Martin Horejsi**, Montgomery, MN (US)

(73) Assignee: **DRI-STEEM Corporation**, Eden Prairie, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1362 days.

(21) Appl. No.: **12/009,134**

(22) Filed: **Jan. 16, 2008**

(65) **Prior Publication Data**

US 2009/0179337 A1 Jul. 16, 2009

(51) **Int. Cl.**
B01F 3/04 (2006.01)

(52) **U.S. Cl.**
USPC **261/118**; 261/DIG. 76; 239/600

(58) **Field of Classification Search**
USPC ..... 261/118, DIG. 15, DIG. 76; 239/600
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

903,150	A	11/1908	Braemer
1,101,902	A	6/1914	Braemer
2,963,284	A	12/1960	Bradford
3,096,817	A	7/1963	McKenna
3,215,416	A	11/1965	Liben
3,268,435	A	8/1966	Sellin
3,386,659	A	6/1968	Rea
3,443,559	A	5/1969	Pollick
3,486,697	A	12/1969	Fraser
3,635,210	A	1/1972	Morrow
3,857,514	A	12/1974	Clifton
3,870,484	A	3/1975	Berg
3,923,483	A	12/1975	Hilmer et al.
3,955,909	A	5/1976	Craig et al.
4,257,389	A	3/1981	Texidor et al.
4,265,840	A	5/1981	Bahler
4,384,873	A	5/1983	Herr
4,913,856	A	4/1990	Morton
4,967,728	A	11/1990	Dueck
5,126,080	A	6/1992	Morton et al.
5,277,849	A	1/1994	Morton et al.

(Continued)

FOREIGN PATENT DOCUMENTS

DE	25 29 057	2/1977
GB	1 444 992	10/1972
WO	WO 00/57112	9/2000
WO	WO 2007/099299 A1	9/2007

OTHER PUBLICATIONS

Nortec Inc., Web Page, SAM-e—Short Absorption Manifold—Submittal Drawings, Printed May 21, 2007, pp. 1-26.

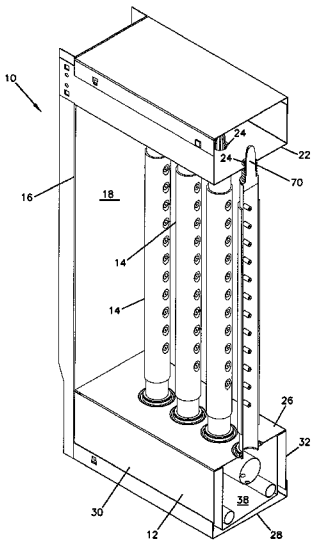
(Continued)

Primary Examiner — Robert A Hopkins
(74) *Attorney, Agent, or Firm* — Merchant & Gould PC

(57) **ABSTRACT**

A steam dispersion system is disclosed. The steam dispersion system includes a header and a mounting plate spaced from the header. A steam dispersion tube including a first end and a second end and an interior cavity defined between the first end and the second end is mounted between the mounting plate and the header. The steam dispersion tube defines a longitudinal axis. A biasing structure is mounted between the mounting plate and the header, wherein the biasing structure applies a biasing force on the steam dispersion tube along a direction parallel to the longitudinal axis of the steam dispersion tube when mounted between the header and the mounting plate.

21 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,372,753	A		12/1994	Morton
5,376,312	A		12/1994	Morton et al.
5,516,466	A		5/1996	Schlesch et al.
5,525,268	A		6/1996	Reens
5,543,090	A	*	8/1996	Morton et al. 261/118
6,065,740	A		5/2000	Morton
6,092,794	A		7/2000	Reens
6,227,526	B1		5/2001	Morton
6,378,562	B1		4/2002	Noone et al.
6,398,196	B1		6/2002	Light et al.
6,485,537	B2		11/2002	Brilmaker
6,488,219	B1		12/2002	Herr
6,631,856	B2		10/2003	Herr
6,824,127	B2		11/2004	Park et al.
7,048,958	B2		5/2006	de Jong et al.
7,150,100	B2		12/2006	Tase et al.
7,744,068	B2		6/2010	Lundgreen et al.
2001/0045674	A1		11/2001	Herr
2002/0089075	A1		7/2002	Light et al.
2002/0163092	A1		11/2002	Park et al.
2004/0026539	A1		2/2004	Herr
2004/0182855	A1		9/2004	Centanni
2005/0212152	A1		9/2005	Reens
2008/0290533	A1		11/2008	Dovich et al.

OTHER PUBLICATIONS

Zotefoams Inc., Zotek® F—High Performance PVDF Foams (for Buildings and Construction)—"Taking foam technology to a new level," pp. 1-2, Oct. 2009.

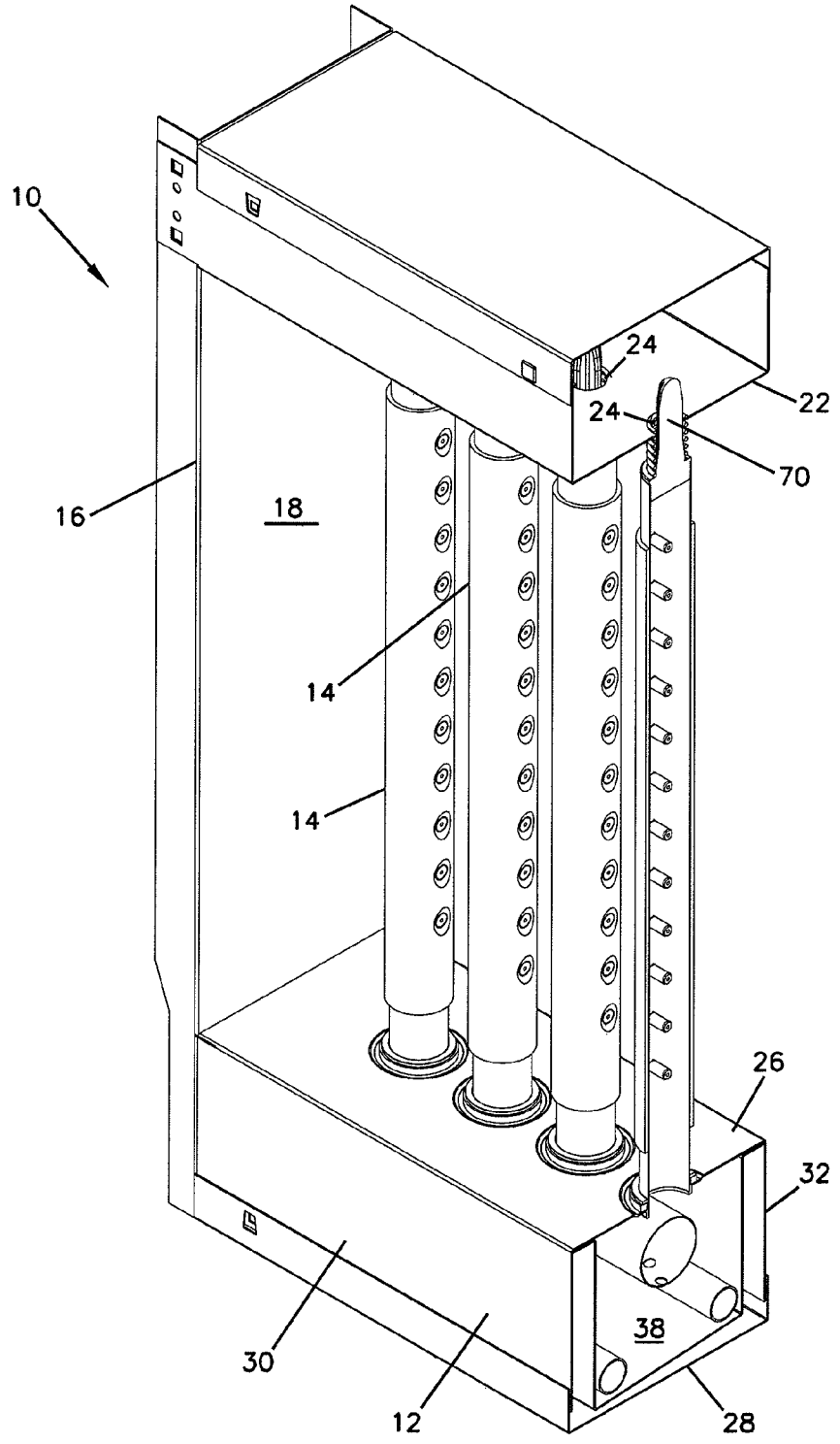
Zotefoams Inc., Zotek® F—High Performance PVDF Foams (for Aviation and Aerospace)—"Taking foam technology to a new level," pp. 1-4, Oct. 2009.

Zotefoams Inc., Zotek® F—High Performance PVDF Foams—"Taking foam technology to a new level," pp. 1-4, Oct. 2009.

Zotefoams Inc., Zotek® F—High Performance PVDF Foams (New Light Weight Materials—Inspiration for Design Innovation)—"Taking foam technology to a new level," pp. 1-6, Date Printed: Dec. 23, 2008.

* cited by examiner

FIG. 1



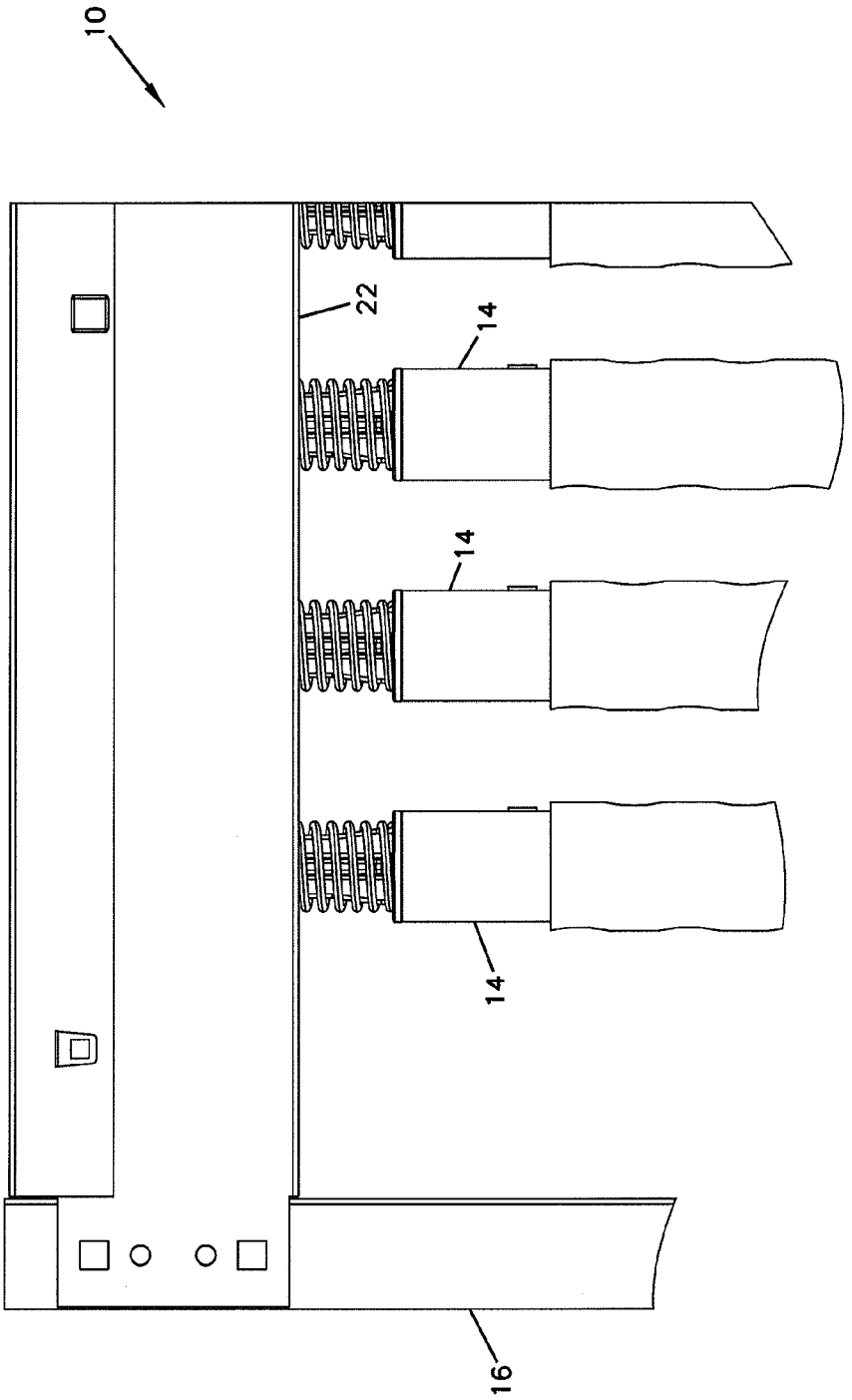


FIG. 2

FIG. 3

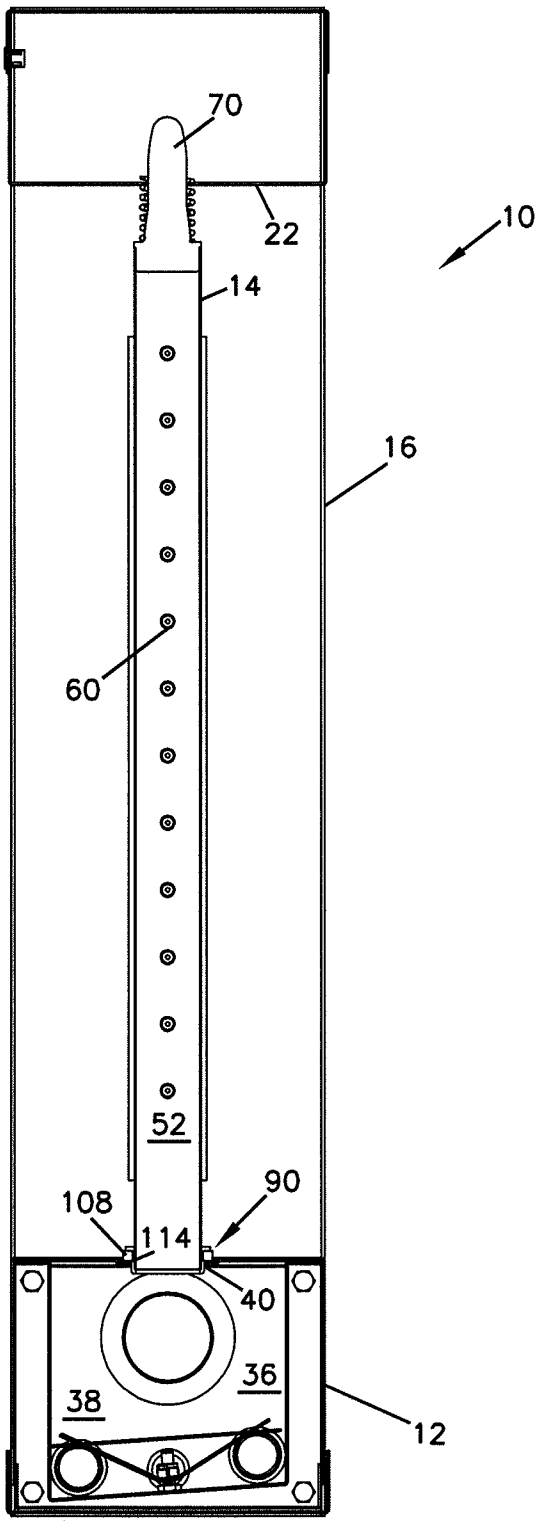


FIG. 4

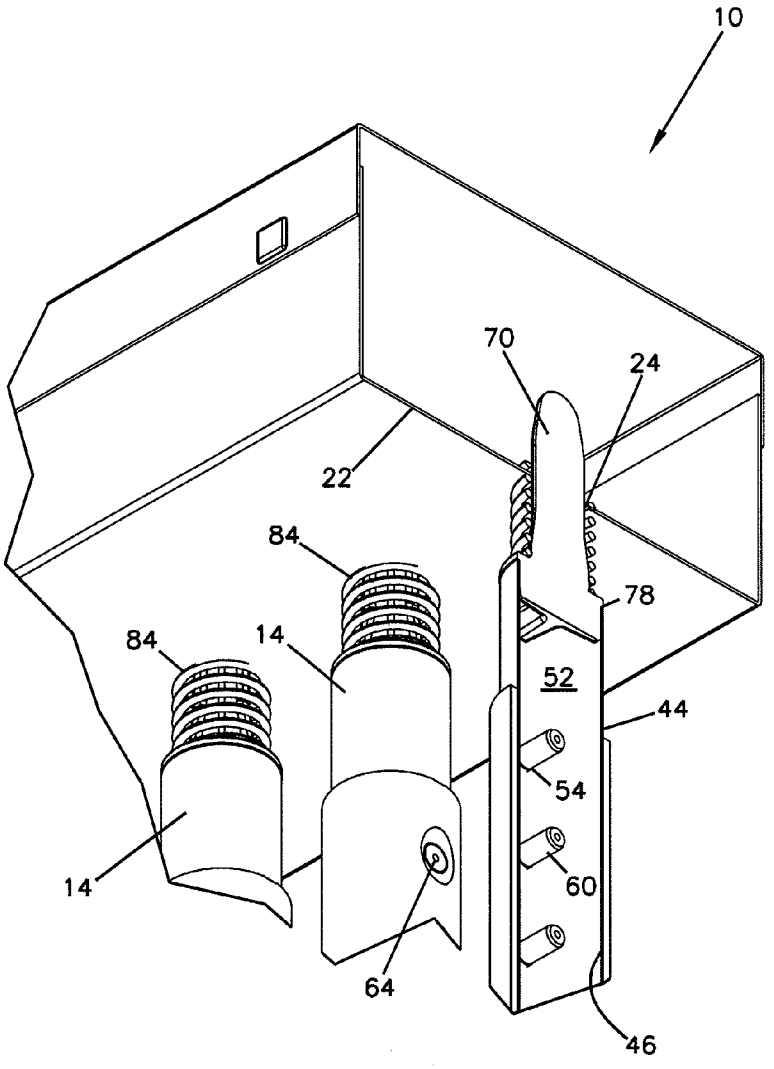


FIG. 5

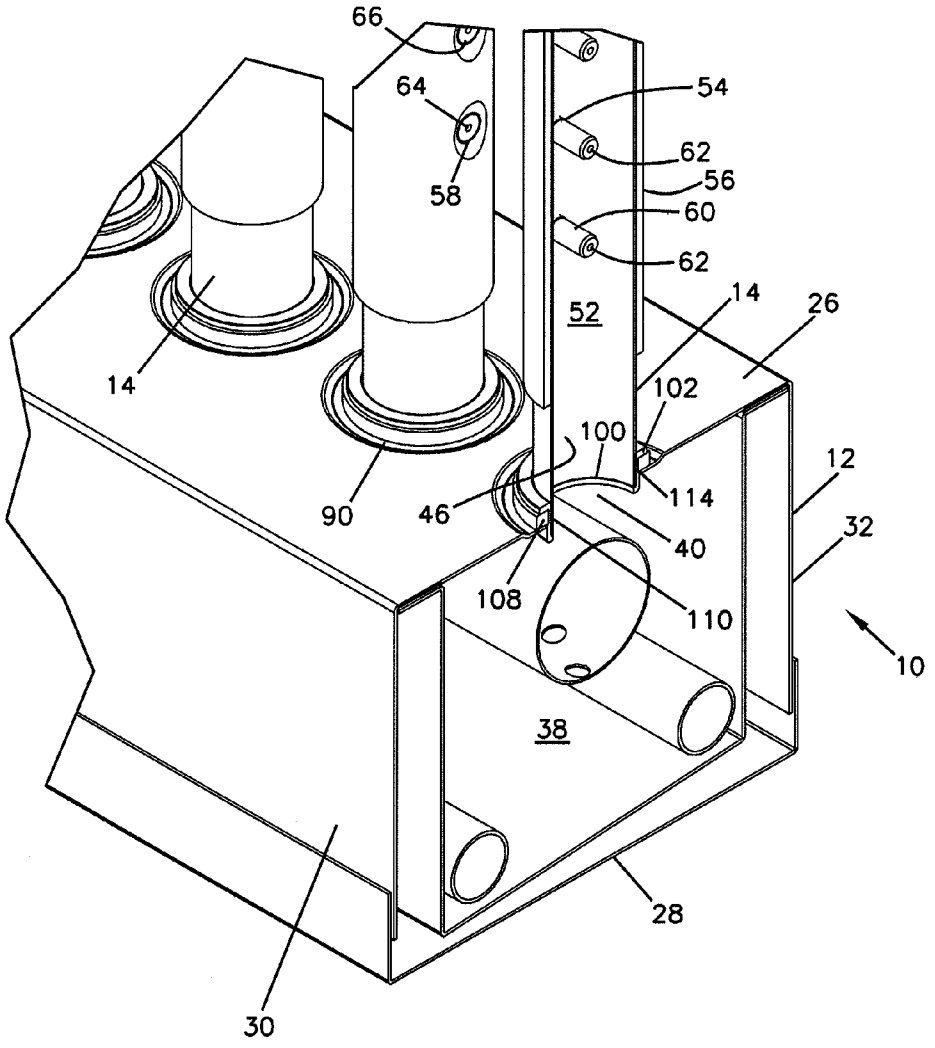

66
64
58
54
62
56
60
62
52
14
26
14
102
100
12
114
90
46
40
32
108
110
10
38
28
30

FIG. 6

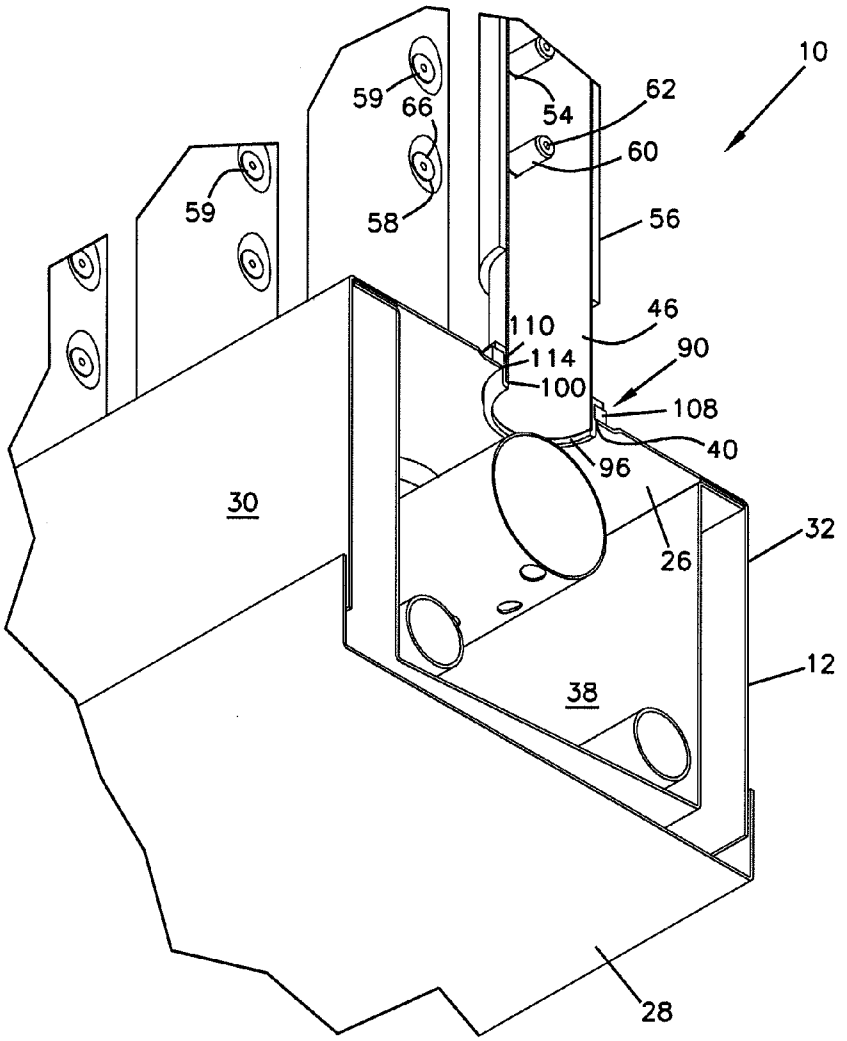

10
59
66
58
59
54
62
60
56
46
110
114
100
90
108
40
96
30
26
32
12
38
28

FIG. 7

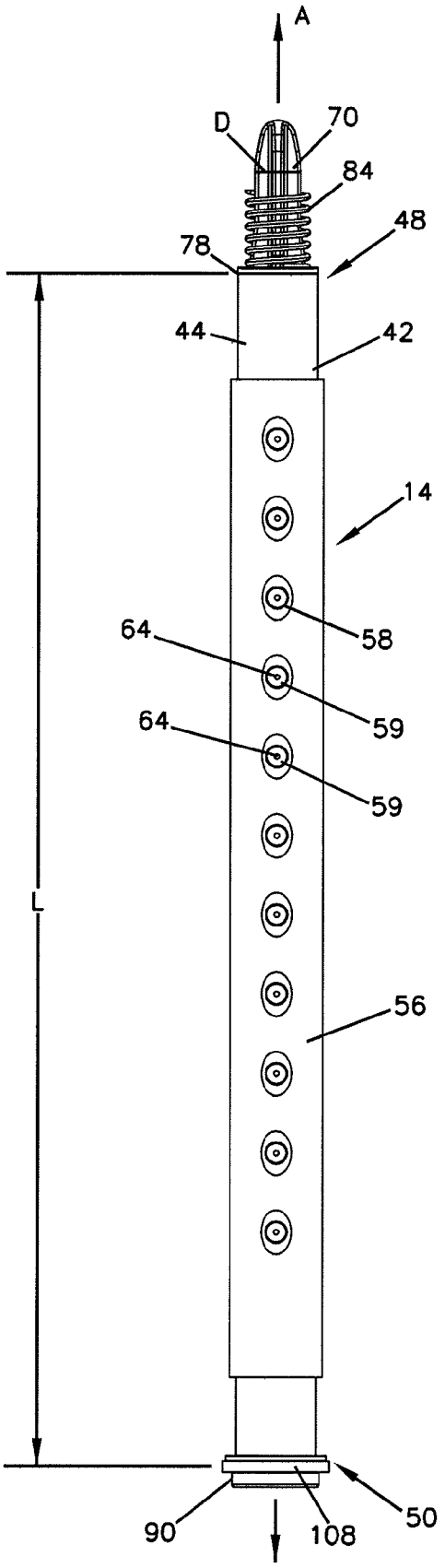


FIG. 8

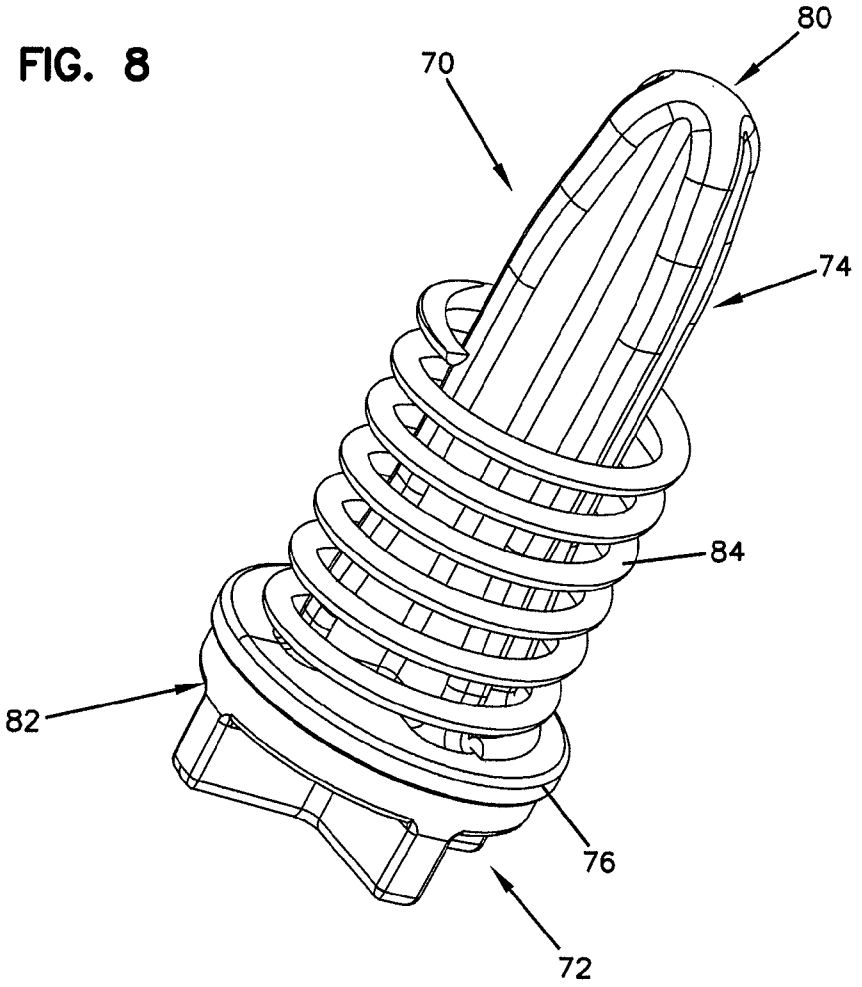
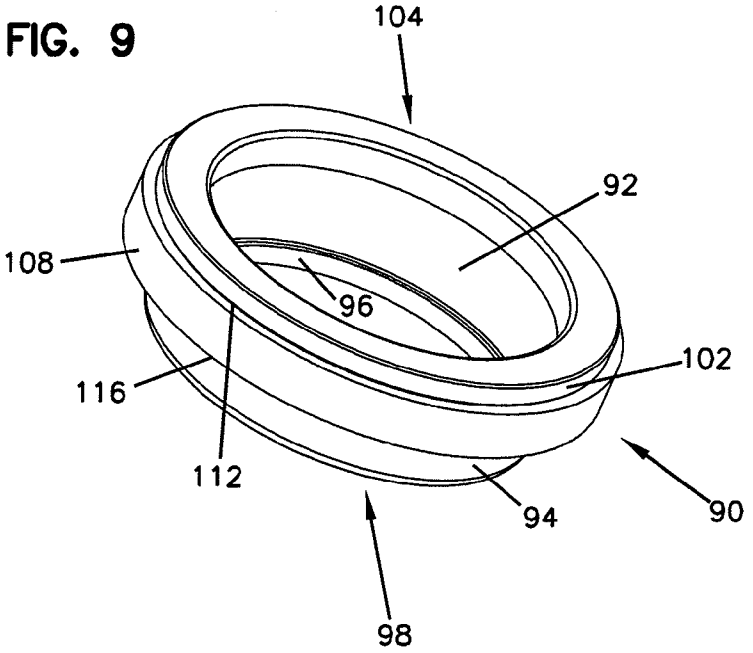


FIG. 9



QUICK-ATTACH STEAM DISPERSION TUBES AND METHOD OF ATTACHMENT

TECHNICAL FIELD

The principles disclosed herein relate generally to the field of steam dispersion humidification. More particularly, the disclosure relates to a steam dispersion system including quick attach and detach steam dispersion tubes and methods of attachment thereof.

BACKGROUND

There are a number of different known configurations for steam dispersion humidification systems. One known configuration utilizes a plurality of closely spaced steam dispersion tubes with steam dispersion nozzles for emitting steam. The plurality of steam dispersion tubes extend across the air duct and provide humidification steam to air flowing therethrough.

The plurality of steam dispersion tubes may extend from a central steam manifold such as a header. In certain configurations, the steam dispersion tubes may extend from a header at one end and be attached to the duct wall at the other end, usually through a bracket or a frame. In certain other configurations, the steam dispersion tubes may be positioned between two headers supplying steam to the tubes.

In most conventional systems, attachment of the steam dispersion tubes, either to the header(s), or to the duct, may be a cumbersome and a time-consuming process, requiring many steps, a large number of parts and tools.

For example, in one conventional method of attachment, holes are first drilled into a header wall. Lengths of tubing are cut into short stubs (e.g., 3 inch stubs). The stubs are aligned with the holes drilled into the header and welded at each stub-to-header joint. The walls of the header might warp from the heat caused by the welding, and, thus, might need to be straightened out. Once the stubs are welded onto the header, either a plastic coupling piece or a hose cuff (i.e., a short piece of hose, for example, 2 inches in length) is slid over each of the stubs. The plastic couplings may be shaped in an inner diameter portion thereof to seat a number of sealing structures such as O-rings, gaskets, etc., to provide a seal with outer diameter of the stubs. The plastic couplings may be friction-fitted onto the stubs. In the case of hose cuffs, hose clamps may be used.

The elongate steam dispersion tubes are slid into the other end of the plastic couplings or the hose cuffs and are sealed with sealing structures such as O-rings, gaskets, etc. Again, a friction fit for the plastic couplings or hose clamps for the hose cuffs may be used for attachment.

In a single header system, the other end of the steam dispersion tubes may be attached to the duct wall through a frame or a bracket. A cap may be welded to the other end of the steam dispersion tube. A nut may be welded to the cap. From thereon, a bolt and a L-bracket may be used to attach the end of the steam dispersion tube to the duct wall.

As described above, conventional spring dispersion tube attachment techniques are cumbersome, time-consuming, and require a large number parts and tools. The lengths of the parts including the stubs and the dispersion tubes have to be cut accurately to provide for correct fitment. Thermal expansion of the parts may lead to failure of the seal joints. Moreover, if the tubes need replacing, detachment thereof may be as cumbersome as their attachment.

Other attachment methods providing convenient and quick mounting of steam dispersion tubes to a steam dispersion system, while providing strong seals, are desired.

SUMMARY

The principles disclosed herein relate to a steam dispersion tube that is configured for quick attachment and detachment of the tube to and from steam dispersion systems. A steam dispersion system utilizing a biasing structure configured to provide a biasing force along the longitudinal axis of the steam dispersion tube when the tube is mounted to a steam dispersion system is also described. Methods of attachment and detachment of steam dispersion tubes is also described.

According to one particular aspect, the disclosure is directed to a steam dispersion tube including a header and a mounting plate spaced from the header, wherein a steam dispersion tube including a first end and a second end and an interior cavity defined between the first end and the second end is mounted between the mounting plate and the header. The steam dispersion tube defines a longitudinal axis. A biasing structure is mounted between the mounting plate and the header, wherein the biasing structure applies a biasing force on the steam dispersion tube along a direction parallel to the longitudinal axis of the steam dispersion tube when mounted between the header and the mounting plate.

A variety of additional inventive aspects will be set forth in the description that follows. The inventive aspects can relate to individual features and combinations of features. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a portion of a steam dispersion system having features that are examples of inventive aspects in accordance with the principles of the present disclosure, portions of the steam dispersion system have been cut-away to illustrate certain internal features thereof;

FIG. **2** is a front view of the steam dispersion system of FIG. **1**;

FIG. **3** illustrates the steam dispersion system of FIG. **1** from a side view;

FIG. **4** illustrates a perspective view of the upper ends of a plurality of steam dispersion tubes having features that are examples of inventive aspects in accordance with the principles of the present disclosure mounted to the steam dispersion system of FIG. **1**;

FIG. **5** illustrates a perspective view of the lower ends of the steam dispersion tubes of FIG. **4** mounted to the steam dispersion system of FIG. **1**;

FIG. **6** illustrates another perspective view of the lower ends of the steam dispersion tubes of FIG. **5**;

FIG. **7** is a side view of the steam dispersion tube having features that are examples of inventive aspects in accordance with the principles of the present disclosure;

FIG. **8** is a perspective view of a plug and a biasing structure configured for attachment to the upper end of the steam dispersion tube of FIG. **7** for mounting to the steam dispersion system of FIG. **1**; and

FIG. **9** is a perspective view of a fitting configured for attachment to the lower end of the steam dispersion tube of FIG. **7** for mounting to the steam dispersion system of FIG. **1**.

DETAILED DESCRIPTION

FIGS. **1-6** illustrate a steam dispersion system **10** having features that are examples of inventive aspects in accordance with the principles of the present disclosure. In the depicted embodiment, the steam dispersion system **10** includes a steam manifold (or chamber) in the form of a header **12** with a plurality of steam dispersion tubes **14** extending from the header **12**. The header **12** receives humidification steam from a steam source (e.g., a boiler, an electric humidifier, a gas humidifier, etc.) and distributes the steam pressure evenly among the tubes **14** protruding therefrom. The steam tubes **14** coming out of the header **12** disperse the steam to the atmosphere at generally atmospheric pressure.

In the depicted embodiment, the steam dispersion system **10** is a single header system, wherein the dispersion tubes **14** extend from a single header **12**. The tubes **14** are attached at the other end to a portion of a frame structure **16** supporting the dispersion system **10**. Other configurations of steam dispersion systems can be provided according to the inventive features of the present disclosure.

The frame structure **16** depicted includes a first sidewall **18**, a second sidewall (not shown in the Figures), and a top wall **22**. The first and second sidewalls are attached to the header **12** and the top wall **22** is spaced from the header **12** and extends between the sidewalls. The top wall **22** defines a plurality of openings **24** that are configured to removably receive ends of the steam dispersion tubes **14**, as will be described in further detail below.

In certain embodiments, the frame structure **16** may be mounted to a duct wall. In other embodiments, the steam dispersion system **10** may be a free-standing system. In addition, even though in the depicted embodiment, the steam dispersion tubes **14** are vertically oriented, in other embodiments, the dispersion system **10** and the tubes **14** may be oriented in other directions. The illustrated system **10** is simply one example system provided to illustrate and describe the inventive features of the disclosure and should not be used to limit the inventive features described herein.

The header **12**, as depicted, includes a top wall **26**, a bottom wall **28**, a front wall **30**, a rear wall **32**, a right sidewall (not shown in the Figures), and a left sidewall **36**, cooperatively defining an interior **38**. In the depicted embodiment, the header **12** includes generally a rectangular cross-sectional shape, wherein the top wall **26**, the bottom wall **28**, the front wall **30**, the rear wall **32**, the right sidewall, and the left sidewall **36** are generally planar, defining substantially right angles thereinbetween. In other embodiments, the header **12** may be of other shapes such as round.

The steam dispersion tubes **14** shown herein extend from openings **40** formed on the top wall **26** of the header **12**. As noted above, the tubes **14** are attached at their other ends to the top wall **22** of the frame structure **16**.

An example embodiment of a steam dispersion tube **14** having features that are examples of inventive aspects in accordance with the principles of the present disclosure is shown in FIG. **7**. The steam dispersion tube **14**, includes a generally cylindrical wall **42** defining an outer surface **44** and an inner surface **46** (see FIG. **6**) extending from a first end **48** to the second end **50**. In other embodiments, the steam dispersion tube **14** may be of other shapes, such as square, triangular, elliptical etc. Also, in other embodiments, the steam dispersion tube **14** may be formed from multiple pieces that are attached together to form the tube. The steam dispersion tube **14** defines a longitudinal axis A.

The steam dispersion tube **14** defines a hollow interior **52** for carrying steam. The steam dispersion tube **14** includes a plurality of openings **54** through the cylindrical wall **42** for emitting the steam. As depicted, the outer surface **44** of the cylindrical wall **42** may be covered with insulation **56**. The insulation **56** may define a plurality of openings **58** through the insulation **56** that are aligned with the openings **54** of the steam dispersion tube **14**. A material that may be suitable for the insulation **56** will preferably be one that meets 25/50 flame/smoke indexes for UL723/ASTM E-84, making it acceptable for use in air ducts/plenums. It has also been found that a material that is suitable for the insulation **56** should preferably be a good insulator, having a low thermal conductivity, preferably, less than about 0.35 Watts/m-K (2.4 in-hr/ft^2 deg F.). One such material that has been identified to meet the above-listed criteria is polyvinylidene fluoride (i.e., PVDF) fluoropolymer. Please refer to U.S. patent application Ser. No. 11/521,083, filed Sep. 13, 2006, entitled "INSULATION FOR A STEAM CARRYING APPARATUS AND METHOD OF ATTACHMENT THEREOF", for further description of a number of insulation materials suitable for the steam dispersion system **10**, the entire disclosure of which application is incorporated herein by reference.

As shown in FIGS. **1** and **4-6**, the tube **14** includes steam delivery points **59** defined by nozzles **60** (i.e., tubelets) provided in the openings **54**. It should be noted that in other embodiments, the steam delivery points **59** may be defined simply by the openings **54** of the tubes **14** without the use of any nozzles.

The nozzles **60**, as depicted, are generally cylindrical in shape and project inwardly in a direction from the outer surface **44** to the interior **52** of the steam dispersion tubes **14**. Each nozzle **60** defines a throughhole **62** which leads to a steam exit **64**. The throughhole **62** is in fluid communication with the hollow interior **52** of the steam dispersion tube **14**.

The nozzles **60** may be coupled to the steam dispersion tube **14** by being press-fit into the openings **54**. Each nozzle **60** may define a shoulder **66** that abuts against the outer surface **44** of the cylindrical wall **42** of the steam dispersion tube **14**.

It should be noted that the nozzles **60** depicted in the embodiment of FIGS. **1-7** is simply one non-limiting example structure for exiting the steam from the dispersion tubes **14**. Other structures are certainly possible. For example, in other embodiments, the nozzles may be formed integrally with the cylindrical wall **42** of the steam dispersion tube **14** instead of being removably disposed. In other embodiments, as discussed above, the steam delivery points **58** may be defined simply by the openings **54** of the tubes **14** without the use of any nozzles **60**. In yet other embodiments, a steam dispersion tube **14** may include a fine mesh configuration, a porous material, or a woven material defining hundreds, even thousands, of steam delivery points.

An example attachment technique for attaching the tubes **14** to the steam dispersion system **10** is described in reference to FIGS. **4-9** As shown in FIGS. **4** and **8**, according to one example, a plug **70** is provided for attachment to and sealing the first end **48** of the tube **14**. The plug **70** may be formed from a polymer or another suitable material for sealing the end of the tube **14**. The plug **70** includes a seal portion **72** and a mounting portion **74** with a flange **76** defined thereinbetween. The seal portion **72** is sized to provide a friction fit within the inner surface **46** of the steam dispersion tube **14**. The flange **76**, in the depicted embodiment, is generally circular and is configured to abut against an edge **78** defined by the first end **48** of the dispersion tube **14** to limit further insertion of the plug **70**.

The mounting portion **74** of the plug **70** is generally elongate. The mounting portion **74** is configured to be inserted

into an opening for mounting the steam dispersion tube **14** to a steam dispersion system. As discussed previously, the opening may be of a frame top wall **22** or another structure for mounting the steam dispersion tubes **14** onto a steam dispersion system **10**. In the depicted embodiment, the mounting portion **74** defines a circular configuration that tapers outwardly going from the upper end **80** of the plug **70** toward the lower end **82**, wherein the diameter D of the mounting portion increases as it extends downwardly toward the flange **76**.

The mounting portion **74** of the plug **70** is also configured to receive a biasing structure **84**. When the steam dispersion tube **14** is mounted to the steam dispersion system **10**, the biasing structure **84** is captured between the flange **76** of the plug **70** and the structure defining the mounting opening (e.g., the top wall **22** of the frame **16**). In the depicted embodiment, the biasing structure **84** is depicted as a coil-spring. Other types of biasing structures such as dampers, other types of springs, etc. may also be used.

According to the present disclosure, the biasing structure **84** may be any resilient structure that provides a biasing force on the steam dispersion tube **14** along a direction parallel to the longitudinal axis A when the tube **14** is mounted to the system **10**.

As shown in FIG. **8**, the coil-spring **84** is slid over the mounting portion **74** of the plug **70** from the upper end **80**, where the diameter D of the mounting portion **74** is smaller. Adjacent the flange **76** of the plug **70**, the diameter D of the mounting portion **74** is increased and is preferably sized to provide a snug friction fit with the coil-spring **84** to lock the spring into place.

It should be noted that the mounting portion **74** of the plug **70** depicted is configured to receive a coil-spring type biasing structure **84**. Depending upon the type and the shape of the biasing structure **84** used, the mounting portion **74** can take on other configurations. The depicted embodiment should not be used to limit the inventive features of the present disclosure.

It should also be noted that although in the depicted embodiment, the biasing structure **84** is shown as being attached to the steam dispersion tube **14**, in other embodiments, the biasing structure **84** can be attached to other parts of the system **10**, such as the top wall **22** of the frame **16**. In this manner, the biasing structure **84** may still be compressed against an end **48** of the tube **14** when the plug **70** is being inserted into an opening **24** of the top wall **22** of the frame **16**.

In other embodiments, the biasing structure **84** may be located at portions of the dispersion tube **14** other than adjacent an end **48** of the tube **14**. For example, in certain embodiments, a coil-spring may be large enough in diameter to go around a portion of the cylindrical wall **42** of the dispersion tube **14** and be compressed against a peripheral flange that may be located at location along the length L of the tube **14**. As long as the biasing structure is configured to apply a biasing force on the steam dispersion tube **14** along a direction parallel to the longitudinal axis A of the steam dispersion tube **14** when mounted on the system **10**, a number of different configurations can be used.

Although illustrated as being a circular coil-spring, the biasing structure **84** can take on other shapes and forms, such as being square in cross-sectional profile.

Now referring to FIGS. **5**, **6**, and **9**, for mounting the second end **50** of the steam dispersion tube **14** into an opening **40** formed on the header **12**, a circular fitting **90** may be used. In one embodiment, the fitting **90** may be made out of metal (e.g., aluminum).

The fitting **90** is shown in further detail in FIG. **9**. As depicted, the fitting **90** includes an inner surface **92** and an outer surface **94**. The diameter of the inner surface **92** of the fitting **90** is sized to receive the outer surface **44** of the dispersion tube **14** with a friction fit. The inner surface **92** of the fitting **90** defines a radially inwardly protruding lip **96** adjacent a lower end **98** of the fitting **90**. The lip **96** is configured to contact an edge **100** defined by the second end **50** of the steam dispersion tube **14** to stop further insertion thereof.

The outer surface **94** of the fitting **90** defines a radially outwardly protruding flange **102** adjacent an upper end **104** of the fitting **90**. The flange **102** is configured to abut a surface such as the top wall **26** of a header **12** when the tube **14** is mounted to a steam dispersion system **10** to limit further insertion of the tube **14**.

A seal structure **108** may be slidably placed onto the fitting **90** and may be positioned underneath the flange **102**. The seal structure **108** is captured between the flange **102** and the top wall **26** of the header **12** when the tube **14** is mounted to the system **10**. In the illustrated embodiment, the seal structure **108** is depicted as a gasket having a square cross-sectional profile. Other types of sealing structures **108** (such as O-rings, etc.) may be utilized.

The fitting **90** may define a recess **110** below the flange **102** for seating the seal structure **108**. The recess **110** is defined by the flange **102** at an upper end **112** and a second smaller lip **114** at a lower end **116**. As noted, when the second end **50** of the steam dispersion tube **14** is mounted to an opening **40** of the header **12**, the seal structure **108** is captured between the top wall **26** of the header **12** and the flange **102** of the fitting **90**.

In mounting a steam dispersion tube **14** to the steam dispersion system **10**, once the plug **70** with the coil-spring **84** and the fitting **90** are frictionally fit to the first and second ends **48**, **50**, respectively, of the dispersion tube **14**, the upper end **48** of the steam dispersion tube **14** is first inserted into an opening **24** formed in the frame **16**. The mounting portion **74** of the plug **70** is inserted with the biasing structure **84** being captured between the frame **16** and the flange **76** of the plug **70**. Then, the upper end **48** of the tube **14** is pushed toward the frame **16**, compressing the biasing structure **84**, until the lower end **50** of the tube **14** (with the fitting **90** mounted thereon) can be inserted into an opening **40** in the header **12**. When the second end **50** is inserted, the seal structure **108** is captured between the flange **102** of the fitting **90** and the top wall **26** of the header **12**. The downward biasing force of the biasing structure **84** ensures a good seal between the fitting **90** and the header opening **40** by compressing the seal structure **108** against the top wall **26** of the header **12**.

If a steam dispersion tube **14** needs to be removed from the system **10**, the upper end **48** of the tube **14** is first pushed upwardly toward the frame **16**, compressing the biasing structure **84**, until the lower end **50** of the tube **14** (with the fitting **90** thereon) can be lifted out of the header opening **40** for removal.

It should be note that the sealing technique described herein for sealing the second end **50** of the tube **14** to the header **12** is simply one example configuration and should not be used to limit the inventive features of the disclosure.

The steam dispersion tube **14** of the present disclosure and the mounting method thereof provides a number of advantages over conventional mounting configurations and techniques.

The method of the present disclosure enables rapid installation and removal of the dispersion tubes **14**, with essentially no tools. The present method of attachment accommodates tolerance stack-up of components, ensuring that the dispersion tubes **14** consistently fit into the frame **16** of the steam dispersion system **10**. The present method of attachment

accommodates for thermal expansion of the dispersion tubes **14** and/or other parts of the dispersion system **10**, such as the header **12**.

The biasing structure **84** of the present system **10** accommodates any vertical displacement between parts of the system **10**. The biasing structure **84** is positioned and configured such that it can either continuously take up any slack or allow for expansion. For example, a continuous downward force is provided on the seal structure **108** to compress it against the header top wall **26**, forming a strong seal with the opening **40** in the header **12**. Also, since the header steam chamber might be pressurized (e.g., up to 8" H_20, 0.29 psi, or 42 lbs/ft^2), the biasing structure **84** can accommodate an upward force that might be created by the displacement of the header top wall **26**.

The continuous downward force provided by the biasing structure **84** may also help seal any features within the header chamber to the header top wall **26**. For example, in a system that includes a header **12** that is divided into more than one chamber with a header divider, the downward force of the biasing structure **84** against the top wall **26** of the header **12** can compress any sealing features on the header divider against the bottom face of the header top wall **26**, ensuring a tight seal between the two or more chambers. Please see U.S. patent application Ser. No. 11/804,991, filed Aug. 20, 2007, entitled "DEMAND ACTIVATED STEAM DISPERSION SYSTEM", for an example steam dispersion system utilizing a header that is divided into more than one chamber, the entire disclosure of which application is incorporated herein by reference. In such a system, a first plurality of steam dispersion tubes may communicate with one chamber while a second plurality of steam dispersion tubes communicate with the other chamber. The first or the second pluralities of tubes may be selectively turned on or off depending upon the humidification demand needed.

Further advantages of the mounting method of the present disclosure includes the possible elimination of parts such as tube stubs, plastic couplings, hose cuffs, large number of sealing structures, etc. Elimination of these parts may lead to reduction in costs for installation. Processes such as drilling, welding, header wall straightening, coupling installation, and O-ring installation may be limited or eliminated. Assembly time may be reduced.

With the mounting method of the present disclosure, the second end **50** of the dispersion tube **14**, with the fitting **90** mounted thereon, protrudes into the interior **38** of the header **12**, versus being butted up as a stub in the conventional techniques. This might ensure that all condensate formed within the tube **14** falls into the header **12** without having to rely upon O-ring seals of plastic couplings used in conventional methods of attachment. Risks of torn O-ring material dislodging and fouling structures such as traps within the header **12** might be reduced or eliminated with the attachment method of the present disclosure.

Although in the foregoing description of the steam dispersion system **10**, terms such as "top", "bottom", "above", "below", "upward", and "downward" may have been used for ease of description and illustration, no restriction is intended by such use of the terms. The steam dispersion system **10** described herein can be used in any orientation within a duct.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the inventive features of the disclosure. Since many embodiments of the inventive aspects of the disclosure can be made without departing from the spirit and scope of the disclosure, the inventive aspects reside in the claims hereinafter appended.

We claim:

1. A steam dispersion system comprising:

a header defining a steam chamber, the header including an opening communicating with an exterior of the header;

a mounting plate spaced from the header;

a steam dispersion tube including a first end and a second end and an interior cavity defined between the first end and the second end, the steam dispersion tube defining a longitudinal axis, wherein the first end of the steam dispersion tube is mounted to the mounting plate and the second end of the steam dispersion tube is mounted to the header such that the opening of the header is in fluid communication with the interior cavity of the steam dispersion tube, the steam dispersion tube defining at least one opening for dispensing steam to an exterior of the steam dispersion tube when mounted between the header and the mounting plate; and

a biasing structure positioned between the mounting plate and the header and axially aligned with the longitudinal axis of the steam dispersion tube.

2. A steam dispersion system according to claim **1**, wherein the biasing structure is located between the first end of the steam dispersion tube and the mounting plate.

3. A steam dispersion system according to claim **1**, wherein the biasing structure is a coil-spring.

4. A steam dispersion system according to claim **1**, wherein the steam dispersion tube is removably mounted to the mounting plate and the header such that the steam dispersion tube can be mounted or removed by compressing the biasing structure.

5. A steam dispersion system according to claim **1**, wherein the steam dispersion tube includes a plug sealing the first end of the steam dispersion tube and the biasing structure mounted to the plug, wherein the plug is removably inserted into an opening formed in the mounting plate and the biasing structure becomes positioned between the first end of the steam dispersion tube and the mounting plate when the steam dispersion tube is mounted between the mounting plate and the header.

6. A steam dispersion tube according to claim **5**, wherein the steam dispersion tube includes a flange adjacent the second end, wherein the steam dispersion tube is removably mounted to the opening of the header with a seal structure captured between the flange and the header, the seal structure compressed by a compression force provided by the biasing structure when the steam dispersion tube is mounted.

7. A steam dispersion tube according to claim **6**, wherein a portion of the steam dispersion tube protrudes into the steam chamber of the header when the steam dispersion tube is removably mounted between the header and the mounting plate.

8. A steam dispersion tube according to claim **1**, wherein the mounting plate is part of a frame structure configured to support a plurality of steam dispersion tubes extending between the mounting plate and the header.

9. A method of attaching a steam dispersion tube to a steam dispersion system, the method comprising:

providing a header defining a steam chamber, the header including an opening communicating with an exterior of the header;

providing a mounting plate at a first distance from the header;

providing a steam dispersion tube including a first end and a second end and an interior cavity defined between the first end and the second end, the steam dispersion tube defining at least one opening for dispensing steam to an exterior of the steam dispersion tube;

mounting the first end of the steam dispersion tube to the mounting plate;

inserting the second end of the steam dispersion tube into the opening of the header; and

placing a biasing structure at a location between the mounting plate and the header in line with a longitudinal axis of the steam dispersion tube.

10. A method according to claim **9**, further comprising providing the biasing structure between the first end of the steam dispersion tube and the mounting plate.

11. A method according to claim **10**, further comprising removing the steam dispersion tube from the steam dispersion system by pushing the steam dispersion tube against the mounting plate to compress the biasing structure against the mounting plate and lifting the second end of the steam dispersion tube out of the opening of the header.

12. A method according to claim **10**, further comprising inserting a plug into the first end of the steam dispersion tube to seal the first end thereof and placing the biasing structure on the plug.

13. A method according to claim **12**, further comprising providing an opening in the mounting plate and inserting a portion of the plug into the opening of the mounting plate with the biasing structure positioned between the first end of the steam dispersion tube and the mounting plate.

14. A method according to claim **9**, wherein the biasing structure is a coil-spring.

15. A method according to claim **9**, further comprising mounting a plurality of steam dispersion tubes between the mounting plate and the header.

16. A method according to claim **9**, further comprising placing a seal structure between the steam dispersion tube and the opening of the header.

17. A steam dispersion tube comprising:

a first end and a second end and an interior cavity defined between the first end and the second end;

at least one steam dispersion opening located between the first end and the second end for dispensing steam to an exterior of the steam dispersion tube;

a plug sealing the first end, the plug defining an elongate portion;

a biasing structure placed on the plug, wherein the biasing structure is configured to compress against the first end of the steam dispersion tube when the elongate portion of the plug is inserted into an opening in a steam dispersion system.

18. A steam dispersion tube according to claim **17**, further comprising a radially outwardly extending flange adjacent the second end.

19. A steam dispersion tube according to claim **18**, further comprising a seal structure located underneath the flange between the second end of the steam dispersion tube and the flange.

20. A steam dispersion tube according to claim **17**, further comprising a plurality of steam dispersion openings located between the first end and the second end for dispensing steam to an exterior of the steam dispersion tube.

21. A steam dispersion system comprising:

a header defining a steam chamber, the header including an opening communicating with an exterior of the header;

a mounting plate spaced from the header;

a steam dispersion tube including a first end and a second end and an interior cavity defined between the first end and the second end, the steam dispersion tube defining a longitudinal axis, wherein the first end of the steam dispersion tube is mounted to the mounting plate and the second end of the steam dispersion tube is mounted to the header such that the opening of the header is in fluid communication with the interior cavity of the steam dispersion tube, the steam dispersion tube defining at least one opening for dispensing steam to an exterior of the steam dispersion tube when mounted between the header and the mounting plate; and

a biasing structure mounted between the mounting plate and the header, wherein the biasing structure applies a biasing force on the steam dispersion tube along a direction parallel to the longitudinal axis of the steam dispersion tube when mounted between the header and the mounting plate.

* * * * *